

1 METHOD AND APPARATUS FOR PREPARING TISSUE SAMPLES FOR SECTIONING

3 FIELD OF THE INVENTION

4 The present invention relates to preparation of tissue samples for histological
5 examination. The invention has particular utility in preparing tissue samples for microtome
6 sectioning prior to microscopic examination, and will be described in connection with such
7 utility, although other utilities are contemplated.

8 BACKGROUND OF THE INVENTION

9 Conventionally, tissue specimens are prepared for microtome sectioning in two
10 sequential stages. In the first stage the tissue specimen is preserved by chemical fixation and the
11 impregnation of paraffin. The specimen is typically held in a cassette to maintain control and
12 segregate it from other samples. The specimen is placed in a fixation solution, typically neutral
13 buffered formalin, to preserve the chemical structure of the tissue. The specimen is then
14 subjected to a series of solvents, typically alcohols and xylene followed by molten paraffin. The
15 solvents remove the water content of the tissue, and provide a bridge to allow the molten paraffin
16 to penetrate the sample and structurally support it. At the end of the first stage the tissue
17 specimen is loose in the cassette, chemically fixed and impregnated with paraffin. In the second
18 stage the tissue specimen is oriented and embedded in a paraffin block in preparation for
19 sectioning. The specimen is placed and oriented in the bottom of a mold and molten paraffin is
20 poured over the specimen. A jig or fixture for attachment to the microtome is placed in the top
21 of the mold and additional molten paraffin is poured to embed this fixture to the paraffin block.
22 The paraffin block is allowed to cool and solidify. The paraffin block is then removed from the

1 mold, exposing the tissue specimen, and then mounted in the clamp of a microtome for
2 sectioning of the specimen.

3 It is important that the specimen is accurately positioned in the embedding mold prior to
4 the paraffin embedding step, so that sectioning of the specimen occurs along appropriate planes
5 to reveal the desired cell structure. Presently, accurate positioning of the specimen is achieved
6 by setting the specimen in a desired position in the embedding mold, and allowing a few drops
7 of molten paraffin wax to fall on the specimen to set the specimen in the desired position.

8 Alternatively, a few drops of molten paraffin wax are placed in the bottom of the embedding
9 mold, and the specimen is set in desired position in the still molten paraffin wax. The molten
10 paraffin wax is allowed to cool and solidify. The solidified paraffin wax holds the specimen in
11 the required position through the second stage, after which more molten paraffin wax is added to
12 the cassette or mold to fully embed the specimen. In place of paraffin wax, molten
13 nitrocellulose, gelatin, and various resins have been used to embed the specimen in a desired
14 orientation through the first stage.

15 Various attempts to improve the preparation of tissue samples for sectioning primarily
16 have involved modifications to the molds or cassettes. See, for example, U.S. Patent Nos.
17 3,982,862; 4,557,903; 4,801,553; 5,080,869; and 6,017,476, which are exemplary.

18 SUMMARY OF THE INVENTION

19 The present invention provides a more efficient and faster way to prepare tissue samples
20 for sectioning. More particularly, in accordance with the present invention, a tissue sample is
21 embedded in a porous embedding media in a desired orientation, processed, and sectioned all

1 while being held in the porous embedding media. The post-tissue processing step of manual
2 embedding in paraffin is eliminated from the process.

3 BRIEF DESCRIPTION OF THE DRAWINGS

4 Various features and advantages of the present invention will be seen from the following
5 detailed description, taken in conjunction with the following drawings, wherein like numerals
6 depict like parts, and wherein:

7 Fig. 1 is a diagrammatic flow chart showing a first method for orienting and processing a
8 tissue sample in accordance with the present invention;

9 Figs. 2-4 are views similar to Fig. 1, showing second and third method for orienting and
10 processing a tissue sample in accordance with the present invention;

11 Fig. 5 is a side elevational view, in section, of an embedding cassette in accordance with
12 another preferred embodiment of the present invention;

13 Fig. 6 is a top plan view of the embedding cassette of Fig. 5;

14 Fig. 7 is a bottom view of the embedding cassette of Fig. 5;

15 Fig. 8 is a view, similar to Fig. 5, of the embedding cassette of Fig. 5 after embedding
16 and processing, with the bottom portion of the cassette removed, and ready for sectioning.

17 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

18 Figure 1 is a diagrammatic flow chart showing a first method for orienting and
19 processing a tissue sample for sectioning in accordance with the present invention. The
20 technician obtains a tissue sample 22 from the examining doctor, nurse, or specialist. The
21 technician typically will be given instructions as to how the tissue sample should be oriented for
22 sectioning on a microtome or other cutting device. The technician orients the tissue sample 22 in

1 a modified cassette-mold combination 24, which is lined with a filter paper 26, or the like. The
2 technician then embeds the tissue sample 22 in the cassette 24 by filling the cassette with molten
3 porous embedding media 28. The porous embedding media should be a material which is
4 normally solid at room temperature and at tissue processing temperatures, and should have a
5 melting point or liquidus point which is below the temperature at which the tissue sample would
6 become denatured or otherwise changed by heat. The porous embedding media also is a material
7 that is porous to treating solutions commonly used in processing and fixing tissues, e.g. acetic
8 acid, acetone, chromic or picric acid, alcohols, aldehydes, mercuric chloride, osmium tetroxide,
9 potassium dichloride, xylene, etc. Applicant has found that low melting point agarose, i.e.
10 agarose having a melting point in the range of about 55 to 65°C, works particularly well as a
11 porous embedding media. Currently preferred is Histogel™ brand of hydroxyethyl agarose
12 available from Wayne Holland.

13 The technician fills the cassette/mold combination 24 with molten porous embedding
14 media 28 until the specimen is completely covered. Generally, but not necessarily, the porous
15 embedding media is added to fill the cassette/mold combination to the top. The cassette/mold
16 combination containing the tissue sample and the liquid embedding media may be cooled on a
17 cold plate 32 to solidify the porous embedding media, or simply left to cool to room temperature.

18 The cassette/mold combination containing the embedded tissue sample is then placed in
19 a tissue processor 36 for conventional fixing and processing. The cassette/mold combination
20 must be oriented in the tissue processor as shown in Figure 1, with the tissue sample and filter
21 paper on the bottom.

1 During conventional automated processing the tissue sample as well as the porous
2 embedding media are infiltrated with paraffin then allowed to cool to room temperature. This
3 forms the paraffin block that contains the tissue oriented in the position the technician originally
4 positioned it in

5 After the tissue sample is processed, the bottom of the cassette 40 is removed, and the
6 filter paper stripped from the paraffin block, exposing the embedded tissue. The cassette/mold
7 combination then is coupled to a microtome 42 for tissue sectioning.

8 A feature and advantage of the present invention that results from using a porous
9 embedding media during fixing and pre-processing, is that the post-processing paraffin wax
10 embedding step is eliminated. In other words, one step in the process is eliminated, along with
11 the technician time, equipment, material, energy and environmental costs associated with the
12 paraffin wax embedding step. Moreover, tissue orientation is assured through the entire process,
13 which is extremely critical for small biopsy examination.

14 Referring to Fig. 2, there is illustrated a second method of orienting and processing a
15 tissue sample for sectioning in accordance with the present invention. The technician obtains a
16 tissue sample 122 from the examining doctor, nurse or specialist. The technician typically will
17 be given instructions as to how the tissue sample should be oriented for sectioning on a
18 microtome or other cutting device. The technician orients the tissue sample 122 on the bottom
19 of a two-piece processing cassette 124 which includes a removable metal bottom dish 126. The
20 technician then embeds the tissue sample 122 in the cassette 124 by filling the cassette with
21 molten porous embedding media 128. As before, the porous embedding media should be a
22 material which is normally solid at room temperature and at tissue processing temperatures, and

1 should have a melting point or liquidus point below the temperature at which the tissue sample
2 would become denatured or otherwise changed by heat. The porous embedding media also
3 should be a material that is porous to treating solutions commonly used in fixing and dehydrating
4 tissues. As before, agarose has been found to be a particularly preferred porous embedding
5 media.

6 The technician fills the cassette/mold combination 124 with molten porous embedding
7 media 128 until the specimen is completely covered. The cassette containing the tissue sample
8 and liquid porous embedding media may be cooled on a cold plate 132 to solidify the porous
9 embedding media. Thereafter, the plastic or metal bottom dish 126 is separated from the
10 remainder of the cassette to expose the embedded tissue sample, which is then passed to a tissue
11 processor 136 for conventional fixing and processing. After the tissue sample is processed, the
12 cassette then is coupled to a microtome 142 for tissue sectioning.

13 As before, by using a porous embedding media pre-processing and fixing, the post-
14 processing paraffin wax embedding step is eliminated.

15 Fig. 3 shows yet another method of orienting and processing a tissue sample for
16 sectioning in accordance with the present invention. Fig. 3 is similar to Fig. 1, in which,
17 however, in place of porous embedding media 28, a pre-formed porous embedding block 129 is
18 employed. The embedding block 129 preferably comprises a phenolic foam which is
19 commercially available as a floral mounting block. A phenolic foam is preferred since it is inert
20 and resistant to the liquids typically employed in tissue fixing and processing, yet is porous to
21 the liquids, widely available, low cost, and easy to cut and shape. The pre-formed embedding
22 block 129 is cut or shaped to fit into the bottom of the cassette/mold combination 24 which is

1 lined with filter paper 26 or the like. However, prior to placing the pre-formed embedding block
2 129 into the cassette/mold combination, the technician forms a hole or depression 127 in the
3 block 129, e.g. by cutting, drilling or punching a blind hole or slot, for accommodating the tissue
4 sample in the desired orientation. The tissue sample 122 is placed in the hole 127. Porous
5 embedding media 28 may be placed in the hole 127 and allowed to solidify to maintain the
6 orientation of the tissue sample 122. The pre-formed embedding block 129 carrying the tissue
7 sample 122 in desired orientation is then placed in the cassette. The cassette containing the
8 embedded tissue sample is then passed to a tissue processor 36 for conventional fixing and
9 processing, as before, prior to sectioning.

10 Alternatively, as shown in Fig. 4, the embedding block carrying the tissue sample may be
11 placed in a cassette and passed directly to a tissue processor for conventional fixing and
12 processing. After the tissue sample is processed, the sample and pre-formed embedding block
13 may then be infiltrated and embedded in molten embedding media which may be a conventional
14 paraffin wax, agarose, nitrocellulose, gelatin, or a resin, and the molten embedding media
15 solidified by cooling, and the embedded sample then sectioned, as before.

16 While the embodiment of Fig. 4 doesn't have the advantages of the Figs. 1-3
17 embodiments of eliminating the post-processing embedding step, the use of a pre-formed porous
18 foam embedding media has advantages in that less paraffin wax or other embedding media is
19 used. Also, the pre-formed foam embedding media may be supplied at the tissue grossing lab so
20 that the Pathologist or assistant could precisely position the tissue sample in a desired
21 orientation, thus eliminating possible miscommunication with the technician.

1 Referring to Figs. 5-8, there is shown an improved cassette 48 for use in accordance with
2 the present invention. It would be appreciated, however, that the cassette as described below,
3 advantageously may be employed in connection with a conventional paraffin wax impregnation
4 process.

5 Referring specifically to Fig. 5, the cassette 48 comprises a two-piece body including a
6 top portion 50 and a bottom portion 52. Top portion 50 has a perforated bottom wall 52, a front
7 wall 54, a back wall 56, and two side walls 58, 60. Preferably, the front wall 54 includes an
8 angled extension wall 64, which provides a writing surface 64 on which a sample identification
9 label may be affixed. If desired, barcode indicia may be affixed to the underside surface 66 of
10 extension wall 64. Bottom portion 52 is snap or friction mounted to top portion 50, and
11 comprises a perforated bottom wall 78 and a bridging side wall 70 which spaces the bottom wall
12 78 from the top portion 50, and serves to contain molten porous embedding media. Bridging
13 side wall 70 includes a pair of tear lines or lines of weakness 72 and a pull tab 74. The cassette
14 including the top and bottom portions 50, 52 are made of a suitable plastic material compatible
15 with the intended processing and fixing.

16 Use of the cassette 48 above described will now be discussed. Again referring to Fig. 5,
17 the technician obtains a tissue sample 76 from the examining doctor, nurse, or specialist. The
18 technician will typically be given instructions as to how the tissue sample should be oriented for
19 sectioning on a microtome or other cutting device. The technician obtains a pre-formed
20 embedding block 78, and forms an opening in the block 78 for the tissue sample, e.g. by cutting,
21 drilling or punching a blind hole or slot. As before, the embedding block 78 preferably
22 comprises a phenolic foam such as a floral mounting block. As mentioned supra, a phenolic

1 foam mounting block is preferred since it is inert and resistant to the liquids typically employed
2 in tissue processing and fixing, porous, widely available, low cost and easy to cut and shape.
3 The embedding block 78 is cut or shaped to fill, at least in part, the bottom portion 52 of cassette
4 48. The embedding block with the tissue sample mounted therein is placed into the bottom
5 portion 52 of cassette 48 with the tissue facing the outside of the cassette. The top portion 50 is
6 then snapped or fitted to the bottom portion 52.

7 The tissue sample may be automatically processed to remove water and fix the tissue
8 sample, etc. using known processing techniques, the last step being the paraffin infiltration step
9 where the tissue sample and porous embedding media are infiltrated with paraffin and allowed to
10 solidify. Bridging side wall 70 is then peeled off the cassette along the line of weakness 72, and
11 the bottom wall 68 removed to expose the embedded tissue sample in the foam block (Fig. 8).
12 The sample may then be sectioned on a microtome.

13 Various changes may be made in the invention. For example, a tissue sample may be
14 oriented in a pre-formed embedding block and then processed in a conventional cassette. Also,
15 the two-part cassette with a removable bridging side wall of Figs. 5-8 may be employed in a
16 conventional two-stage fixing and embedding process.

17 It should be understood that, while the present invention has been described in detail
18 herein, the invention can be embodied otherwise without departing from the principles thereof,
19 and such other embodiments are meant to come within the scope of the present invention as
20 defined in the following claim(s):
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